CERTIFICATION OF TRANSLATION

I, ***Joo-hyun Hong***, an employee of Y.P. LEE, MOCK & PARTNERS of The Goryo Bldg., 1575-1 Seocho-dong, Seocho-gu, Seoul, Republic of Korea, hereby declare under penalt y of perjury that I understand the Korean language and the English language; that I am ful ly capable of translating from Korean to English and vice versa; and that, to the best of m y knowledge and belief, the statement in the English language in the attached translation o f ***Korean Patent Application No. 10-2003-0026007*** consisting of 26 pages, have the same meanings as the statements in the Korean language in the original document, a copy of w hich I have examined.

Signed this 18th day of May 2007

Hong JooHyun

ABSTRACT

[Abstract of the Disclosure]

Provided is a flat panel display in which white balance can be maintained according to the difference in the thicknesses of an active layer of each driving thin film transistor (TFT) and the size of a crystal grain and without changing the size of the driving TFT, wherein appropriate brightness is obtained by supplying optimum currents to the sub-pixels and decrease in the life span is prevented. The flat panel display includes: pixels including a plurality of sub-pixels including organic electroluminescence devices; and a driving TFT including a semiconductor active layer having channel areas formed in the sub-pixels, and connected to the organic electroluminescence devices and applying current to the organic electroluminescence devices, wherein the thicknesses of the channel areas of the active layer of the driving TFT are varied according to the sub-pixels.

[Representative Drawing]

FIG. 3

SPECIFICATION

[Title of the Invention]

Flat panel display with TFT

[Brief Description of the Drawings]

FIG. 1 is a plane view of a structure of an active layer on a thin film transistor (TFT) in an active matrix type electroluminescence display device according to an embodiment of the present invention;

FIG. 2 is a plane view of crystallized structures of a second active layer of a driving TFT of red, green, and blue sub-pixels;

FIG. 3 is a cross-sectional view of different thicknesses of the second active layer of the driving TFT of red, green, and blue sub-pixels in line I-I direction in FIG. 2;

FIG. 4 is a graph of a relation between a size of a crystal grain and a current mobility;

FIG. 5 is a graph of a relation between an energy density and a size of a crystal grain in an excimer laser annealing (ELA) method;

FIG. 6 is a partially enlarged view of one sub-pixel in FIG. 1;

FIG. 7 is an equivalent circuit diagram of a unit pixel in FIG. 6;

FIG. 8 is a cross-sectional view in line II-II direction in FIG. 6; and

FIG. 9 is a cross-sectional view in line III-III direction in FIG. 6.

[Detailed Description of the Invention]

[Object of the Invention]

[Technical Field of the Invention and Related Art prior to the Invention]

The present invention relates to an active matrix type flat panel display including a thin film transistor (TFT), and more particularly, to a flat panel display including a TFT

having a polycrystalline silicon as an active layer, and channel areas of the active layers in a switching TFT and a driving TFT having different thickness and crystal grains of different sizes from each other.

A thin film transistor (TFT) used in a flat display device such as a liquid display device, an organic electroluminescence display device, and an inorganic electroluminescence display device is used as a switching device for controlling operations of pixels and a driving device for driving the pixels.

The TFT includes a semiconductor active layer having a drain area and a source area doped with impurities of high concentration and a channel area formed between the drain area and the source area, a gate insulating layer formed on the semiconductor active layer, and a gate electrode formed on the gate insulating layer which is located on an upper part of the channel area of the active layer. The semiconductor active layer can be classified into an amorphous silicon and polycrystalline silicon according to crystallized status of the silicon.

The TFT using the amorphous silicon has an advantage in that a deposition can be performed at a low temperature, however, it also has disadvantages in that an electrical property and a reliability of the TFT are degraded and it is difficult to make the display device be a larger area. Thus, the polycrystalline silicon is mainly used recently. The polycrystalline silicon has a higher mobility of tens of - hundreds of $cm^2/V.s$, and low high frequency operation property and leakage current value, thereby it is suitable to be used in the flat panel display of high resolution and larger area.

On the other hand, as described above , the TFT is used as the switching device or the driving device of the pixel in the flat panel display. An organic electroluminescence display device of an active matrix type in an active driving method includes two TFTs per pixel.

The organic electroluminescence device has an emission layer made of an organic material between an anode electrode and a cathode electrode. In the organic electroluminescence device, when a positive voltage and a negative voltage are respectively applied to the electrodes, holes injected from the anode electrode are

moved to the emission layer through a hole transport layer, and electrons are injected into the emission layer through an electron transport layer from the cathode electrode. The holes and electrons are recombined on the emission layer to produce exitons. The exitons are changed from an excited status to a ground status, and accordingly, phosphor molecules of emission layer are radiated to form an image. In case of a full-color electroluminescence display, pixels radiating red (R), green (G), and blue (B) colors are disposed as the electroluminescence devices to realize the full colors.

However, in the above described organic electroluminescence display device, the light emitting efficiency of each of red, green, and blue light emitting layers emitting each color is different according to the color. When applying a predetermined constant current, a certain color has low light emitting brightness and another color has high light emitting brightness according to the light emitting efficiency, and thus it is difficult to obtain appropriate color balance or white balance. For example, since the light emitting efficiency of the green light emitting layer is 3 to 6 times greater than that of the red light emitting layer or the blue light emitting layer, a greater current should be applied to the red and blue light emitting layers to balance white balance.

Thus, conventionally, in order to balance white balance, Japanese Patent Publication No. Hei 5-107561 discloses applying voltages, that is, Vdd values, which are supplied via driving lines, differently to each of the pixels.

Also, Japanese Patent Publication No. 2001-109399 discloses a method for balancing white balance by adjusting the size of a driving TFT. That is, when a width of a channel of a channel area of a driving TFT is W and a channel length is L, the ratio W/L is designed differently for each of the red, green, and blue pixels to adjust the current flow amount flowing through each of the red, green, and blue organic electroluminescence devices.

Japanese Patent Publication No. 2001-290441 discloses maintaining white balance by forming pixels having different sizes. In other words, a light emitting surface area of a green light emitting area which has the highest light emitting efficiency is formed to the smallest compared to surface areas of the red and blue light emitting

areas, thereby maintaining white balance and obtaining a long life time. Such a difference in the light emitting surface areas can be made by the surface area of an anode electrode.

Alternatively, a method of controlling brightness by controlling the current amount by varying the range of voltages applied through data lines to the red, green, and blue pixels is known.

However, the above described methods do not consider the crystal size with respect to flat panel displays using polycrystalline silicon. In other words, the crystal grain of the TFT active layer can have various shapes and sizes according to the crystallization methods, and the current mobility varies according to the various shapes and sizes of the crystal grain, and in that case, white balance cannot be maintained despite using the above described methods.

On the other hand, in the organic electroluminescence device, when the current amount flowing through the organic electroluminescence device exceeds a predetermined limit value, the brightness per unit surface area is greatly increased by the current amount greater than the limit value, and thus the life span of the organic electroluminescence device is rapidly decreased. Accordingly, optimum amount of current should be supplied to each of the sub-pixels regarding the life span of the organic electroluminescence device as well.

[Technical Goal of the Invention]

The present invention provides a flat panel display capable of balancing white balance according to the thickness of an active layer of each of driving thin film transistors (TFT) and the size of crystal grain.

The present invention also provides a flat panel display capable of balancing white balance without changing the size of the active layer of the driving TFTs at a predetermined constant driving voltage.

The present invention also provides a flat panel display having appropriate brightness by supplying optimum current to each of the sub-pixels and preventing decrease in the life time.

[Structure and Operation of the Invention]

According to an aspect of the present invention, there is provided a flat panel display comprising: pixels including a plurality of sub-pixels including organic electroluminescence devices; and a driving thin film transistor (TFT) including a semiconductor active layer having channel areas formed in the sub-pixels, and connected to the organic electroluminescence devices and applying current to the organic electroluminescence devices, wherein with respect to sub-pixels having different colors, the thicknesses of the channel areas of the active layer of the driving TFT are varied according to the colors of the sub-pixels, and the semiconductor active layer is formed of polycrystalline silicon, and the polycrystalline silicon is formed in a crystallization method using laser.

The sub-pixels may have two different colors.

The thickness of each of the channel areas may be different according to the colors of the sub-pixels.

The thickness of each of the channel areas may be determined to be inversely proportional to the current value flowing through each of the sub-pixels at a predetermined driving voltage.

The thickness of each of the channel areas may be determined to be inversely proportional to the current mobility of the channel areas of the active layer of the sub-pixels.

The sub-pixels may have red, green, or blue color, and the thickness of the channel areas of the driving TFT of the green sub-pixels may be greater than the thickness of the channel areas of the driving TFT of the red and blue sub-pixels.

The sub-pixels may have red, green, or blue color, and the thickness of the channel areas of the driving TFT of the red sub-pixels may be greater than the thickness of the channel areas of the driving TFT of the green and blue sub-pixels.

The sub-pixels may have red, green, or blue color, and the thickness of channel areas may be reduced in the sequence of the green, blue, and red sub-pixels.

The semiconductor active layer may be formed of polycrystalline silicon, and the size of a crystal grain of the channel areas of the driving TFT may be different according to each of the sub-pixels.

The size of the crystal grain of each of the channel areas may be determined to be inversely proportional to the current value flowing through each of the sub-pixels at a predetermined driving voltage.

The size of a crystal grain of each of the channel areas may be determined to be inversely proportional to the current mobility of the channel areas of the active layer of each of the sub-pixels.

The sub-pixels may have red, green, or blue color, and the size of the crystal grain of the channel areas of the driving TFT of the green sub-pixels may be smaller than the size of the crystal grain of the channel areas of the driving TFT of the red and blue sub-pixels.

The sub-pixels may have red, green, or blue color, and the size of the crystal grain of the channel areas of the driving TFT of the red sub-pixels may be smaller than the size of the crystal grain of the channel areas of the driving TFT of the green and blue sub-pixels.

The sub-pixels may have red, green, or blue color, and size of the crystal grain of channel areas may be increased in the sequence of the green, blue, and red sub-pixels.

The semiconductor may be formed of polycrystalline silicon, and the size of a crystal grain of the channel areas of the driving TFT may be different according to each of the sub-pixels.

The channel areas of each of the sub-pixels may be formed by irradiating laser simultaneously.

Preferred embodiments of the present invention will now be described with reference to the attached drawings.

FIG. 1 is a plane view of an active layer structure of a thin film transistor (TFT) in an active matrix type organic electroluminescence display according to an embodiment of the present invention. In FIG. 1, red (R), green (G), and blue (B) sub-pixels are repeatedly arranged in a longitudinal direction (up-and-down direction in FIG. 1) in a pixel of the organic electroluminescence display. However, the arrangement of the pixels is not limited to the above structure, and the sub-pixels of respective colors can be arranged in various patterns such as a mosaic pattern, or a grid type pattern to construct the pixel. Also, a mono color flat panel display can be used instead of a full-color flat panel display shown in FIG. 1.

In the organic electroluminescence display, a plurality of gate lines are arranged in a transverse direction (left-and-right direction in FIG. 10), and a plurality of data lines 52 are arranged in a longitudinal direction. Also, driving lines 53 for supplying power are arranged in a longitudinal direction. The gate lines 51, the data line 52, and the driving lines 53 are disposed to surround one sub-pixel.

On the other hand, in above construction, each sub-pixel of the R, G, and B pixels includes two TFTs such as a first TFT and a second TFT. First TFT 10r, 10g, and 10b transmit a data signal to a light emitting device according to a signal of the gate line 51 to control operations of the light emitting device, and second TFT 20r, 20g, and 20b drive the light emitting device. The number of TFTs and arrangement of TFTs can be varied according to the properties of the display device and a driving method of the display device in various ways.

The first TFTs 10r, 10g, and 10b and the second TFTs 20r, 20g, and 20b respectively include first active layers 11r, 11g, and 11b, and second active layers 21r, 21g, and 21b, and these active layers have channel areas which will be described later, though not shown in the drawings. The channel areas are disposed approximately on center portions of the first active layers 11r, 11g, and 11b, and a second active layers

21r, 21g, and 21b that are formed in a length direction and correspond to areas that are formed as a gate electrode is insulated in upper portions thereof.

In the above described organic electroluminescence display, the thickness of the channel areas of the second active layers constructing the driving TFT may be varied according to each of the sub-pixels. According to an embodiment of the present invention, the thickness of the channel areas of the second active layers may be varied according to the colors. That is, a channel area of a second active layer 21r forming a red pixel R, a channel area of a second active layer 21g forming a green pixel G, and a channel area of a second active layer 21b forming a blue pixel B are formed to have different thicknesses. If the sub-pixels have other colors than red, green, and blue, the thicknesses of the channel areas may be varied according to the colors.

On the other hand, according to an embodiment of the present invention, the first active layers 11r, 11g, and 11b, and the second active layers 21r, 21g, and 21b may be formed of a polycrystalline silicon thin film. Also, as illustrated in FIG. 3, the thickness of the second active layers 21r, 21g, and 21b, particularly the thickness of the channel areas, are formed to be different for each of red R, green G, and blue B pixels. Here, it is sufficient when the thicknesses of channel areas which are center portions of the second active layers 21r, 21g, and 21b are different, but due to the complexity in designing the above structure, the thicknesses of the entire second active layers are designed differently from each other. In the embodiments of the present invention which will be described hereinafter, the type of crystal grain for each sub-pixel is differentiated but the present invention is not limited thereto. Also, the first active layers 11r, 11g, and 11b of each pixel may have the crystalline structure.

According to an embodiment of the present invention, as the thicknesses of the channel areas of the active layers of a second TFT that is used as a driving thin layer are differentiated according to each of red, green, and blue pixels, the entire sizes of the active layers, that is, the planar surface areas, can be formed to be the same and white balance can be maintained at a predetermined constant driving voltage. Hereinafter, this principle will be described in more detail.

As described above, in the organic electroluminescence display, brightness of red, green, and blue sub-pixels differs according to the difference in the light emitting efficiency of the light emitting layers, and thus white balance could not be maintained at a predetermined constant current value. Table 1 shows current values which are to be applied to each of the red, green, and blue sub-pixels to satisfy conditions such as the light emitting efficiency of red, green, and blue organic light emitting layers that are generally and widely used in the current organic electroluminescence display, and white balance.

[Table 1]

	Red	Green	Blue
Efficiency (Cd/A)	6.72	23.37	4.21
Pixel current	0.276	0.079	0.230
Pixel current ratio	3.5	1	2.9

As can be seen from Table 1, the current value to be applied to balance white balance is the smallest in the case of the green sub-pixel from among the red, green, and blue sub-pixels, the current value for the red sub-pixel is the largest, and the current value for the blue sub-pixel is larger than the green sub-pixel and smaller than the red sub-pixel.

The current values can be made differently by differentiating the thicknesses of the channel areas of the active layer of the second TFTs 20r, 20g, and 20b of FIG. 1 which are a driving TFTs applying current to the light emitting device.

The changes in the thickness of the channel area of the TFT active layer cause a lot of changes in the TFT properties, and when the thickness of the channel area on the active layer is thin, the current mobility increases on the channel area, and accordingly, excellent TFT properties can be obtained. Such effects are obtained not only in the case of polycrystalline silicon but also in the case of amorphous silicon.

Accordingly, according to the embodiment as illustrated in FIG. 3, the thicknesses of the channel areas of the second active layers 21r, 21g, and 21b can be

controlled to be inversely proportional to the current value flowing through the sub-pixels at a predetermined constant driving voltage. That is, as described above, when red, green, and blue sub-pixels are included, the second active layer 21r of the red sub-pixels through which the greatest current needs to be applied are made to be the thinnest, and the second active layer 21g of the green sub-pixels through which the smallest current needs to be applied are made to be the thickest. Accordingly, the thicknesses of the channel areas of the second active layers can be formed to decrease in the sequence of the green, blue, and red sub-pixels.

Also, the thicknesses of the channel areas of the second active layers 21r, 21g, and 21b may be controlled to be inversely proportional to the current mobility of the channel areas thereof. That is, as described above, when red, green, and blue sub-pixels are included, in order to maintain white balance, the red sub-pixels to which the greatest current needs to be applied need to have the greatest current mobility, and thus and thus the second active layer 21r is formed to be the thinnest, and the green sub-pixels, to which the smallest current needs to be applied must have the smallest current mobility, and thus the second active layer 21g is formed to be the thickest. Accordingly, the thicknesses of the second active layers can be reduced in the sequence of the green, blue, and red sub-pixels. The above described control of the thickness of the channel areas of the active layers also applies to active layers formed of amorphous silicon.

Meanwhile, as the thicknesses of the channel areas of each of the active layers are controlled, when crystallizing from amorphous silicon to polycrystalline silicon, the crystal size can be varied, and thus the differences can be made in the current mobility. Furthermore, when the crystal size is controlled by, for example, an ELA method, without performing an additional process, active layers having different crystal sizes can be obtained by simultaneously irradiating laser to the three regions.

FIG. 2 illustrates the second active layers of the second TFTs of red, green, and blue sub-pixels, which are formed in a crystalline structure of different polycrystalline silicon thin layers for each of the red, green, and blue sub-pixels. The polycrystalline

silicon thin layers are formed of amorphous silicon thin layers that are crystallized in a well known excimer laser annealing (ELA) method. Meanwhile, FIG. 3 is a cross-sectional view of FIG. 2 take along line I-I.

As can be seen from FIG. 3, the second active layer 21r of the red sub-pixel is formed on a silicon thin layer having a first crystalline structure 61 having a smallest thickness d1, and the second active layer 21g of the green sub-pixel is formed on a silicon thin layer having a second crystalline structure 62 having the thickest thickness d2, and the second active layer 21b of the blue sub-pixel is formed on a silicon thin layer having a third crystalline structure 63 having a middle-sized thickness 3d. Accordingly, as can be seen from FIG. 2, the second active layer 21r of the red sub-pixel is formed in the first crystalline structure 61 having the largest size, the second active layer 21g of the green sub-pixel is formed on the second crystalline structure 62 having the smallest size, and the second active layer 21b of the blue sub-pixel is formed on the third crystalline structure 63 having a middle size. As will be described later, the manufacture thereof is possible by differentiating the thicknesses of amorphous silicon and forming to polycrystalline silicon by crystallization and then patterning the polycrystalline silicon.

As described above, by varying the thicknesses of the silicon thin layers and thus varying the size of crystal grain, differences can be made in the current mobility, and as illustrated in FIG. 4, as the size of the crystal grain is increased, the current mobility is increased, showing an almost linear relationship.

Accordingly, according to the embodiment with reference to FIG. 2, the size of the crystal grain of the channel areas of the second active layers of the driving TFT of the red sub-pixels, which require large current mobility, is formed to be the largest, the size of the crystal grain of the channel areas of the second active layers of the driving TFT of the blue sub-pixels, which require less current mobility than the red sub-pixels, is formed to be smaller than that of the red sub-pixels and bigger than that of the green sub-pixels, and the size of the crystal grain of the channel areas of the second active

layers of the driving TFT of the green sub-pixels, which require the smallest current mobility, is formed to be the smallest.

Accordingly, the less the thickness of the silicon thin layers, the greater the energy density of laser irradiating amorphous silicon, and thus a larger crystal grain can be obtained.

Meanwhile, when the amorphous silicon thin layer is irradiated by laser having too great energy density, the size of the crystal grain may be rather decreased, and thus it is preferable that the thickness d1 of the silicon thin layer of the first crystalline structure 61, from which the second active layer 21r of the driving TFT of the red sub-pixels is to be formed and which requires larger crystal grain, is not too thin. FIG. 5 is a graph of a relation between an energy density of irradiated laser and a size of a crystal grain when crystallizing an amorphous silicon thin layer having a thickness of 500 Å using the ELA method.

Accordingly, according to an embodiment of the present invention, the thicknesses of the channel areas of the second active layers of each of the sub-pixels can be decreased in the sequence of the green, blue, and red sub-pixels. The thicknesses of the silicon thin layers can be formed differently by a well known half-tone method using photo-lithography. That is, photo masks having different light transmittivty with respect to each of the second active layers of the red, green, and blue sub-pixels are used, corresponding to areas where the second active layers are to be formed, by exposing, developing, and etching. Thus layers having different thicknesses can be formed in a single process.

Thus, as the thickness d1 of the silicon thin layer, from which the second active layer 21r of the red sub-pixel is to be formed, is made smaller than the thickness d3 of the silicon thin layer, from which the second active layer 21b of the blue sub-pixel is to be formed, and the thickness d3 of the silicon thin layer, from which the second active layer 21b of the blue sub-pixel is to be formed, is made smaller than the thickness d2 of the silicon thin layer, from which the second active layer 21g of the green sub-pixel is to be formed, and accordingly, the crystal grain of the second active layer 21r of the red

sub-pixel is formed to be the largest, that of the blue sub-pixel is formed to be smaller than that of the red sub-pixels and larger than that of the green sub-pixel, and that of the green sub-pixel is formed to be the smallest, and the current mobility can be increased in the sequence of the green, blue, and red sub-pixels. Consequently, the current flowing through the sub-pixels can be increased in the sequence of the green, blue, and red sub-pixels at a predetermined constant driving voltage. Accordingly, white balance can be easily maintained at a predetermined constant driving voltage. Furthermore, according to the present invention, the size of the crystal grain can be formed differently by irradiating laser one time due to the differences in the thicknesses, thereby simplifying the manufacturing process.

Meanwhile, each of the sub-pixels of the organic electroluminescence display as described above has a structure as illustrated in FIGS. 6 through 9.

FIG. 6 is a partially enlarged plane view of a sub-pixel among the sub-pixels in FIG. 1, and FIG. 7 is a view of an equivalent circuit of the sub-pixel shown in FIG. 6.

Referring to FIG. 7, the respective sub-pixel of the active matrix type organic electroluminescence display according to an embodiment of the present invention includes two TFTs such as a switching TFT 10 for switching and a driving TFT 20 for driving, a capacitor 30, and an electroluminescence (EL) device 40. The number of TFTs and the number of capacitors are not limited thereto, and more TFTs and capacitors can be included according to a design of a desired device.

The switching TFT 10 is operated by a scan signal which is applied to the gate line 51 to transfer a data signal which is applied to the data line 52. The driving TFT 20 decides a current flowing into the EL device 40 according to the data signal transferred through the switching TFT 10, that is, voltage difference between a gate and a source. The capacitor 30 stores the data signal transferred through the switching TFT 10 for one frame unit.

The organic electroluminescence display devices having the structure shown in FIGS. 6, 8, and 9 are formed to realize the above circuit.

As shown in FIGS. 6, 8, and 9, a buffer layer 2 is formed on an insulating substrate 1 made of glass, and the switching TFT 10, the driving TFT 20, the capacitor 30, and the EL device 40 are disposed on the buffer layer 2.

The switching TFT 10 includes a gate electrode 13 connected to the gate line 51 for applying TFT on/off signals, a source electrode 14 formed on the gate electrode 13 and connected to the data line 52 for supplying the data signal to the first active layer, and a drain electrode 15 connecting the switching TFT 10 with the capacitor 30 to supply power source to the capacitor 30. A gate insulating layer 3 is disposed between the first active layer 11 and the gate electrode 13.

The capacitor 30 for charging is located between the switching TFT 10 and the driving TFT 20 for storing a driving voltage required to drive the driving TFT 20 for one frame unit, and may include a first electrode 31 connected to the drain electrode 15 of the switching TFT 10, a second electrode 32 formed to overlap with the first electrode 31 on an upper part of the first electrode 31 and connected to a driving line 53 through which the power source is applied, and an interlayer dielectric layer 4 formed between the first electrode 31 and the second electrode 32 to be used as a dielectric substance, as shown in FIGS. 6 and 8. The structure of the capacitor 30 is not limited to the above, for example, a gate insulating layer may be used as the dielectric layer.

As shown in FIGS. 6 and 9, the driving TFT 20 includes a gate electrode 23 connected to the first electrode 31 of the capacitor 30 for supplying TFT on/off signals, a source electrode 24 formed on an upper part of the gate electrode 23 and connected to the driving line 53 for supplying a reference common voltage to the second active layer 21, and a drain electrode 25 connecting the driving TFT 20 with the EL device 40 for applying a driving voltage to the EL device 40. A gate insulating layer 3 is disposed between the second active layer 21 and the gate electrode 23. Here, the channel area of the active layer 21 of the driving TFT 20 has a different crystallization structure from that of the channel area of the first active layer 11 of the switching TFT 10, that is, a different size in the crystal grain.

On the other hand, the EL device 40 displays a predetermined image information by emitting lights of red, green, and blue colors according to flows of the current. As shown in FIGS. 6 and 9, the EL device 40 includes an anode electrode 41 connected to the drain electrode 25 of the driving TFT 20 for receiving positive power source from the drain electrode 25, a cathode electrode 43 disposed to cover the entire pixel for supplying negative power source, and an organic emission layer 42 disposed between the anode electrode 41 and the cathode electrode 43 for emitting lights. Unexplained reference numeral 5 denotes an insulating passivation layer made of SiO_2, and reference numeral 6 denotes an insulating planarized layer made of acryl, or polyimide.

The above layered structure of the organic electroluminescence display according to the embodiment of the present invention is not limited thereto, and the present invention can be applied to any different structures from the above.

In the above described organic electroluminescence display, the channel areas of the second active layers of the second TFT which are the driving TFT thereof can be formed to have different thicknesses, and thus the size of the crystal grains to be crystallized is different, and thus the current mobility for each pixel of each color is different, and thus currents having different values flow through the sub-pixels at a predetermined constant driving voltage, thereby maintaining white balance. Furthermore, current having an optimal value can be applied to the EL device of each of the sub-pixels, and thus the durability of the device can be improved.

Next, a method of manufacturing an organic electroluminescence display having the above described structure according to an embodiment of the present invention will be described.

First, as illustrated in FIGS. 10 and 11, a buffer layer 2 is formed on an insulating substrate1 of glass material. The buffer layer 2 can be formed using SiO_2 and can be deposited in a plasma enhanced chemical vapor deposition (PECVD) method, an atmospheric pressure chemical vapor deposition (APCVD) method, a low pressure chemical vapor deposition (LPCVD) method, or an electron cyclotron resonance (ECR) method. Also, the buffer layer 2 can be deposited to have a thickness about 3000 Å.

An amorphous silicon thin layer may be deposited on the buffer layer 2. The amorphous silicon thin layer is patterned one time using photo-lithography using a half-tone mask and can be formed as silicon thin layers having different thicknesses, and the thicknesses of areas where second active layers of each of the red, green, and blue sub-pixels are to be formed are formed as, as illustrated in FIG. 3, d1, 2d, and d3. The difference in the thicknesses can be made by one-time exposure by differentiating the light transmittivity of optical masks, and areas where second active layers of each of the red, green, and blue sub-pixels are to be formed are coated with photoresist and then exposed and developed using masks having different light transmittivity and etched, and thus areas where first active layers having different thicknesses from each other are to be formed can be formed.

The amorphous silicon thin layer manufactured in this manner can be crystallized into polycrystalline silicon thin layer using various methods. Here, the crystallized polysilicon silicon thin layer obtain crystal grain having different sizes for each of the colors of the sub-pixels or for each of portions corresponding to the second active layer of the second TFT as illustrated in FIG. 2 and 3.

As described above, in order to obtain crystalline structure as illustrated in FIGS. 2 and 3, laser is simultaneously irradiated using an ELA method. That is, a crystal structure having differently sized crystal grains can also be obtained by single scanning due to the thickness difference.

After forming the polycrystalline silicon thin layer, as illustrated in FIGS. 1 and 2, first active layers 11r, 11g, and 11b of the first TFTs 10r, 10g, and 10b and second active layers 21r, 21g, and 21b of the second TFTs 20r, 20g, and 20b are patterned on the polycrystalline silicon thin layer for each of the sub-pixels. The active layers may be patterned at the same time when the above described amorphous silicon thin layers are formed to have different thicknesses, or may be patterned one time after depositing a gate insulating layer and a gate electrode which will be described below.

After performing the patterning process of the active layers, the gate insulating layer is deposited on the patterned layers in PECVD, APCVD, LPCVD, or ECR method,

and a conductive layer is formed using MoW or Al/Cu, and so on, and patterned to form the gate electrode. The active layer, the gate insulating layer, and the gate electrode may be patterned in various orders and methods.

After patterning the active layer, the gate insulating layer, and the gate electrode, N-type or P-type impurities are doped on the source and drain areas.

After the doping process, as illustrated in FIGS. 8 and 9, an interlayer insulating layer 4 and a passivation layer 5 are formed, and the source electrodes 14 and 24 and drain electrodes 15 and 25 are connected via contact holes, and then a planarized layer 6 is formed.

Meanwhile, the EL device 40 contacting the second TFT 20 can be formed in various ways. First, an anode electrode 41 contacting the drain electrode of the second TFT 20 by ITO is formed and then patterned, and an organic layer 42 is formed on the anode electrode 41. The organic layer 42 may be a low molecular or high molecular organic layer.

In case where the low molecular organic layer is used, a hole injection layer, a hole transfer layer, an organic emission layer, an electron transfer layer, and an electron injection layer may be formed by being stacked in a single or a combination structure. Also, various organic materials such as copper phthalocyanine (CuPc), N,N-Di(naphthalene-1-yl)-N,N'-diphenyl-benzidine (NPB), and tris-8-hydroxyquinoline aluminum (Alq3) can be used. The low molecular organic layer is formed in a vacuum evaporation method.

The high molecular organic layer may include the hole transfer layer and an emission layer. Here, the hole transfer layer is formed using poly(3,4-ethylenedioxythiophene (PEDOT), and the emission layer is formed using a high molecular organic material such as poly-phenylenevinylene (PPV)-based material or polyfluorene-based material in a screen printing method or in an inkjet printing method.

After forming the organic layer, the cathode electrode 43 is entirely deposited using Al/Ca, or patterned. An upper part of the cathode electrode 43 is sealed by a glass or a metal cap.

In above descriptions, the present invention is applied to the organic electroluminescence display device, however, the scope of the present invention is not limited thereto. The TFT according to the present invention can be applied to any display devices such as a liquid crystal display (LCD), and inorganic electroluminescence display devices.

[Effect of the Invention]

According to the present invention, following effects can be obtained.

First, white balance can be maintained while including active layers having the same size without changing the size of the active layers of the TFT or the driving voltage.

Second, since appropriate current is applied to each of the sub-pixels, appropriate brightness can be obtained, and deterioration in the life time can be prevented.

Third, problems such as decrease in the aperture rate can be solved by controlling the current amount flowing through the device without increasing the surface area the driving TFT occupies for each of the sub-pixels, and reliability can be improved.

While the present invention has been particularly shown and described with reference to exemplary embodiments thereof, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present invention as defined by the following claims.

What is claimed is:

1. A flat panel display comprising:

pixels including a plurality of sub-pixels including organic electroluminescence devices; and

a driving thin film transistor (TFT) including a semiconductor active layer having channel areas formed in the sub-pixels, and connected to the organic electroluminescence devices and applying current to the organic electroluminescence devices,

wherein with respect to sub-pixels having different colors, the thicknesses of the channel areas of the active layer of the driving TFT are varied according to the colors of the sub-pixels, and the semiconductor active layer is formed of polycrystalline silicon, and the polycrystalline silicon is formed in a crystallization method using laser.

4. The flat panel display of claim 1, wherein the thickness of the channel areas is determined to be inversely proportional to the current value flowing through each of the sub-pixels at a predetermined constant driving voltage.

5. The flat panel display of claim 1, wherein the thickness of the channel areas is determined to be inversely proportional to the current mobility of the active layer of each of the sub-pixels.

6. The flat panel display of claim 1, wherein the sub-pixels are formed to have red, green, and blue colors, and the thickness of the channel areas of the driving TFT of the green sub-pixels is greater than the thickness of the channel areas of the driving TFT of the red and blue sub-pixels.

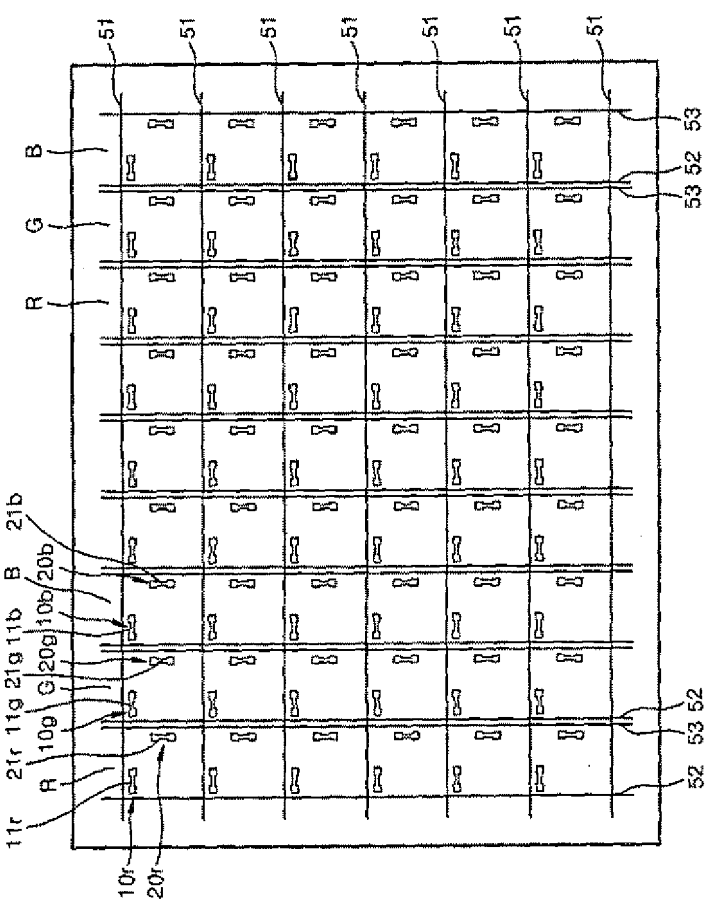
7. The flat panel display of claim 1, wherein the sub-pixels are formed to have red, green, and blue colors, and the thickness of the channel areas of the driving TFT of the red sub-pixels is greater than the thickness of the channel areas of the

driving TFT of the green and blue sub-pixels.

8. The flat panel display of claim 1, wherein the sub-pixels are formed to have red, green, and blue colors, and the thickness of the channel areas is reduced in the sequence of the green, blue, and red sub-pixels.

16. The flat panel display of claim 1, wherein the channel areas of each of the sub-pixels are formed by simultaneously irradiating laser.

FIG. 1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53
52
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52
52
B
G
R
21b
B
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G
11g
21r
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11r
10r
20r

FIG. 2

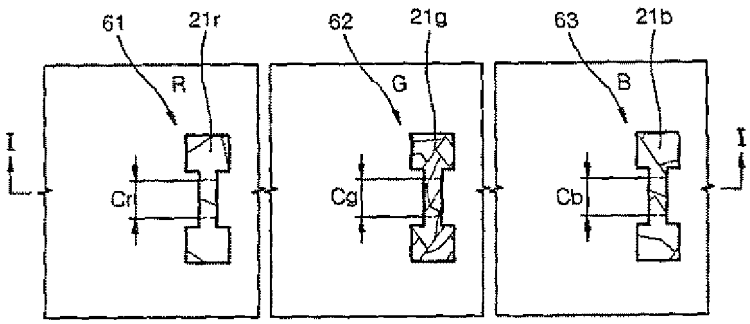


FIG. 3

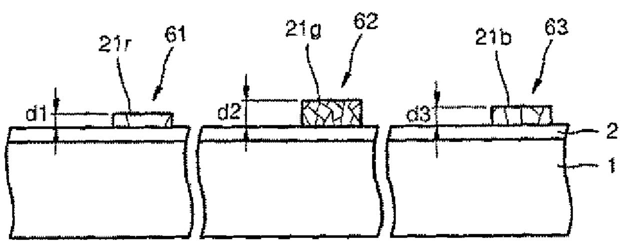


FIG. 4

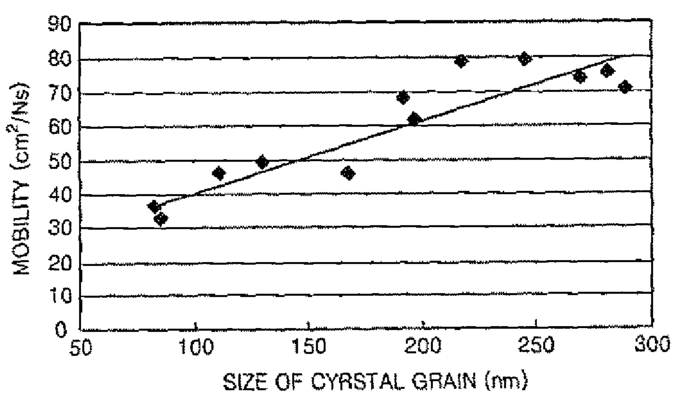

MOBILITY (cm²/Ns)
0
10
20
30
40
50
60
70
80
90
50
100
150
200
250
300
SIZE OF CYRSTAL GRAIN (nm)

FIG. 5

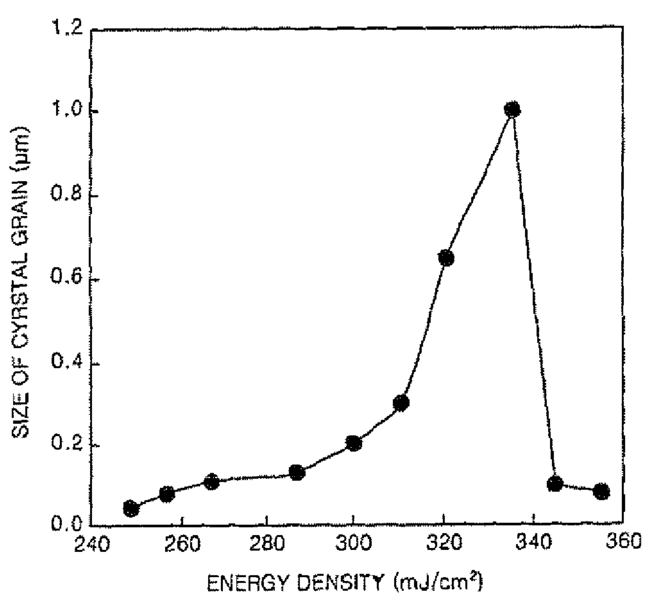
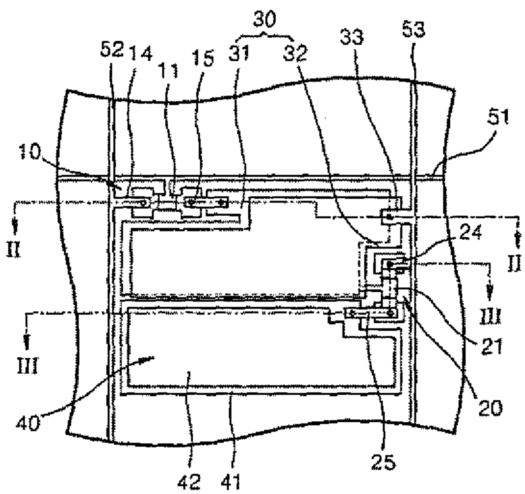
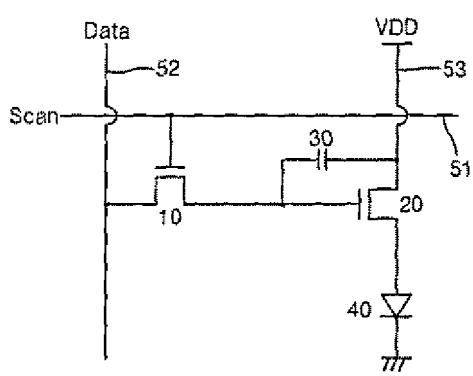

SIZE OF CYRSTAL GRAIN (μm)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
240
260
280
300
320
340
360
ENERGY DENSITY (mJ/cm²)

FIG. 6



30
52
14
11
15
31
32
33
53
51
10
II
24
II
III
21
III
20
40
25
42
41

FIG. 7



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53
Scan
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51
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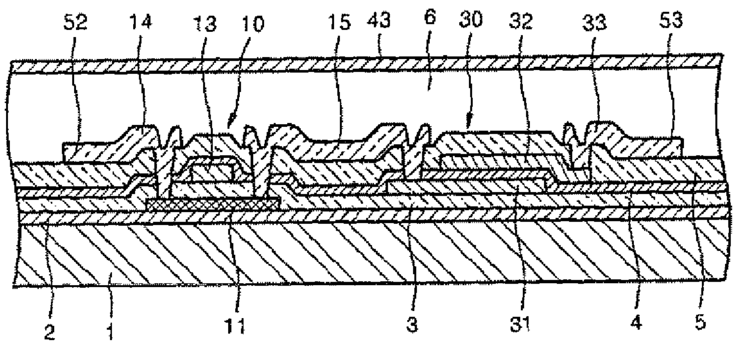
10
40

FIG. 8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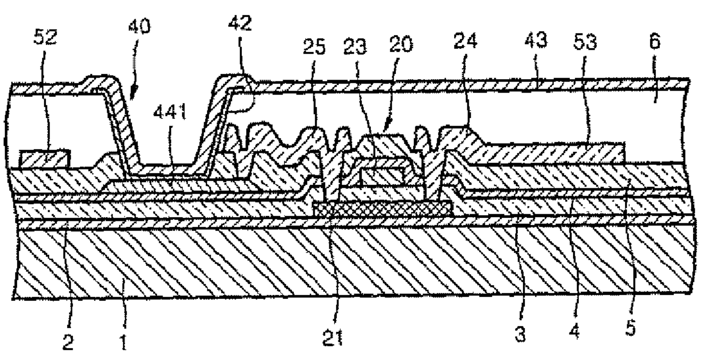
2
1
11
3
31
4
5

FIG. 9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21
3
4
5